PROBE WIRE MEASUREMENTS

CONTENTS

FIGURES

1. GENERAL

1.1 This section provides REA borrowers, consulting engineers, contractors and other interested parties with technical information for using a probe wire during noise investigations. Probe wire investigations may be undertaken where the telephone plant has been operational for several years, where the telephone plant has just been placed and is not yet operational or along routes where construction of new telephone plant has been proposed.

1.2 A probe wire is used to measure the magnitude of the overall or individual harmonic frequency earth return current of a power line (See TE&CM Section 452, Paragraph 9.3).

1.3 A probe wire consists of a length of insulated wire and two ground rods. The wire may be two conductor lamp cord with the two conductors shorted together at each end. A one hundred foot probe wire is

the length most commonly used. When measurements are made at a distance from the power line, such as along a HVDC transmission line, a probe wire length of up to five hundred feet may be used. The ground rods are usually the same type used for station protection at subscriber premises.

1.4 Earth return current is usually measured along a power line after it has been determined that circuit noise in a telephone system cannot be reduced to an acceptable level through further work on the telephone plant. In other words, cable balance is excellent, cable shield continuity has been verified by measurement and the source of noise is through induction. Another situation where the measurement of power system earth return current might be desirable is where a new cable extension is planned parallel to an existing power line. The expected power influence can be calculated from the average earth return current as determined from measurements of earth return current along the power line. Thus if it is found that a neutralizing transformer is required, it can be included in the transmission design or the proposed routing changed.

1.5 The technique for measuring power line earth return currents is effective on single-, two-, or three-phase power systems. As with any measurement technique it is important that the user be aware of limitations and/or problems relating to its use.

1.5.1 A probe wire measurement requires more time to set up and complete than does an exploring coil measurement. It is necessary to lay the probe wire on the ground and drive two ground rods.

1.5.2 The resulting earth return value is influenced by differences in potential along the earth surface. These differences in potential are produced by earth currents from sources such as metallic fences, buried pipes, etc.

2. MEASUREMENT OF EARTH RETURN CURRENT

2.1 The selection of a location for measurement of power line earth return currents is an important consideration. It must be free from factors that might produce erroneous results. Things to avoid are:

2.1.1 Power line spans that include secondary distribution conductors should be avoided. The presence of secondary distribution conductors alters the magnetic field and can cause significant error in the results of earth return measurements.

2.1.2 Discontinuities in the power line such as bridged taps, distribution transformers, power factor correction capacitors corners or dead-ends should also be avoided. These will distort the magnetic field from the power line and cause errors in earth return current measurements.

2.1.3 Metal fences located beneath or near a power line and parallel to it should be avoided. The magnetic field from a grounded metal fence may be stronger at the earth's surface than that from the power line. This could result in a large error in earth return current measurements.

2.1.4 Sections where power and telephone lines share poles should be avoided unless the joint-use extends through the entire exposure. Recorded results of measured earth return current are not the true values where the entire exposure is in joint-use. The error is due to the cable's location near the power conductors. Variations in earth return current along the power line and the predominant harmonics of the fundamental frequency can still be determined.

2.1.5 A probe wire should not be used where a buried cable or metallic pipe line is located beneath or very near the power line. The magnetic field from either of these may be stronger than that from the power line at the earth's surface. This will produce erroneous results.

2.2 After the site has been selected for the measurements estimate the distance to the lowest wire of the power line. Enter this value in the appropriate space (1) on the form for power system wave form analysis. A sample form for recording the data is shown in Figure 1. The sample form is designed for use when measuring power system earth return currents with either a probe wire or an exploring coil (See TE&CM Section 452.2).

2.2.1 Find the height correction factor when a 100 foot probe wire is used in the table at the bottom of the analysis form for the estimated power line height and enter it in the appropriate space. The correction factors were derived by the equation:

$$\text{Correction Factor} = 20 \log M + 94.2$$

Where:

$$M = 0.14 \times 10^{-6} \ell \times \log \left(\frac{(400 + D)}{D} \right) \text{ Henries}$$

With:

ℓ = Length of probe wire in feet
D = Distance between lowest power conductor and probe wire in feet

2.2.2 When using probe wires other than 100 feet in length or where distance between the probe wire and power conductor exceeds 60 feet new correction factors will have to be computed by the equation in Paragraph 2.2.1. <u>Change the sign of the calculated correction factor before entering it in the analysis form.</u>

POWER SYSTEM CURRENT WAVE FORM ANALYSIS

Central Office ____

Power Company ______________________________ Sheet No. ______________

Primary Voltage ______________________________ Date ______________

Test Location ______________________________ Time ______________

Test Condition ______________________________ Tester ______________

☐ 100 foot probe wire ______________ ☐ Exploring coil type: ______________

Power Line Height (Average) __________ Feet (1); Correction Factor ______________ dB (2)

FREQ. Hz.	Harmonic	TIF Weighted (Weighing Switch in C-MSG.)			Unweighted (Weighing Switch in 50 KHZ-FLAT or 20/F)					TIF Contribution	
		Reading dB (3)	(2)+(3) $I_f \cdot W_f$ dBA (4)	$I_f \cdot W_f$ wtd. amps (5)	Flat Reading dB (6)	20/f Factor (7)	(6)+(7) or 20f Reading (8)	(8)+(2) -40 dB =(I_f)dBA (9)	I_f amps (10)	(3)-(8) +40 dB =(T_f) dB (11)	T_f (12)
60	1					-9.5					
120	2					-15.6					
180	3					-19.1					
240	4					-21.6					
300	5					-23.5					
360	6					-25.1					
420	7					-26.4					
480	8					-27.6					
540	9					-28.6					
600	10					-29.5					
660	11					-30.4					
720	12					-31.1					
780	13					-31.8					
840	14					-32.5					
900	15					-33.1					
960	16					-33.6					
1020	17					-34.2					
1140	19					-35.1					
1260	21					-36.0					
1380	23					-36.8					
1500	25					-37.5					
1620	27					-38.2					
1740	29					-38.8					
1860	31					-39.4					
1980	33					-40.0					
2100	35					-40.4					
2220	37					-40.9					
2340	39					-41.4					
2460	41					-41.8					
2580	43					-42.2					
2700	45					-42.6					
2820	47					-43.0					
2940	49					-43.3					
3060	51					-43.7					
3180	53					-44.0					
PWR SUM RMS			(I·T)dB	I·T				(I) dBA	I	(TIF)dB	TIF

Height Correction Factor dB		Height of Power Line Above Probe Wire or Coil								
		20'	25'	30'	35'	40'	45'	50'	55'	60'
	100' Probe Wire	0.5	1.1	1.6	2.1	2.5	2.9	3.3	3.6	3.9
	Exploring Coil	19.5	21.5	23.0	24.4	25.5	26.6	27.5	28.3	29.1

FIGURE 1

2.3 Drive a ground rod at one end of the selected location. Connect one end of the insulated probe wire to the ground rod and extend it along the surface of the ground parallel to the power line as shown in Figure 2 for its full length. Drive a second ground rod at that end of the probe wire. Connect the probe wire to the tip terminal of the spectrum analyzer and with a short length of wire connect the second ground rod to the ring terminal. The spectrum analyzer must have a high input impedance; 100,000 ohms or more.

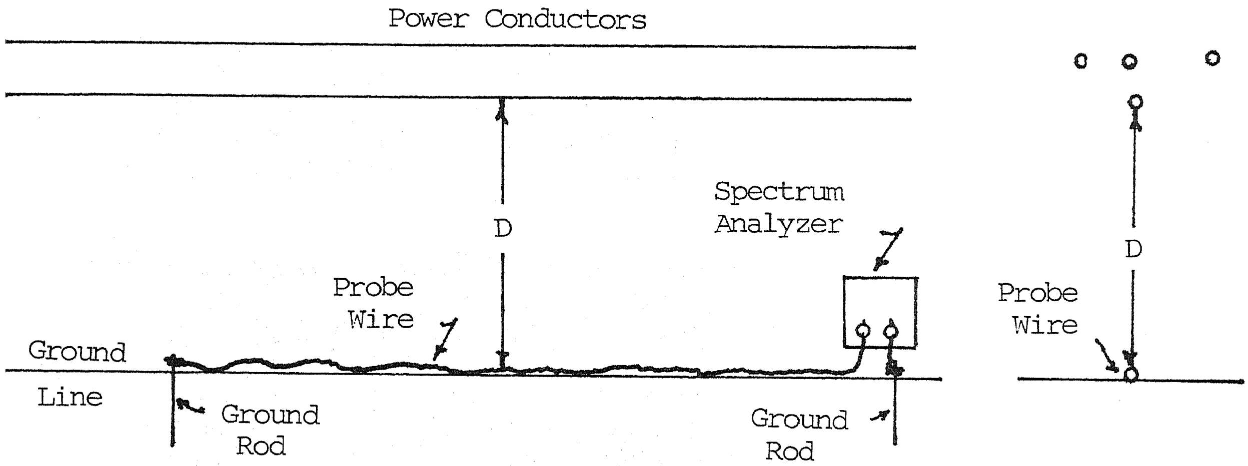

FIGURE 2
PROBE WIRE CONFIGURATION

2.3.1 When using a spectrum analyzer designed for telephone system measurements set function switch to the BRDG600 position. Place the weighting switch to the desired weighting (C-MSG, 50 kHz FLAT or 20/f).

2.3.1.1 A 50 kHz FLAT weighting filter may not be available on all test equipment. The 3 kHz FLAT weighting should not be used for these measurements since it may prove necessary to measure frequencies higher than the filter cutoff frequency.

2.3.1.2 For analysis on test equipment that does not have a 20/f weighting filter, factors for 20/f weighting in dBrn have been included in column (7) of the sample form shown in Figure 1. 20/f weighted values are derived by adding 20/f weighting factors to the recorded flat weighted readings.

2.3.2 Successively set the spectrum analyzer to the frequencies listed on the form. Read and record the values in dBrnc on the analysis form for each frequency with the weightings shown. When using test equipment that does not have 20/f weighting the values will have to be calculated from recorded values of flat weighted readings as shown on the form. (See Paragraph 3).

2.3.2.1 Switch the operating mode from spectrum analysis to NMS (noise measuring set). Make an overall reading with C-MSG and 20/f weighting. Record the results in the appropriate spaces of the form. These overall readings may be converted to numerical overall values of TIF weighted amperes (I·T) and amperes (I) respectively (See TE&CM Section 452) because they are independent of frequency.

2.3.2.2 An overall flat weighted measurement does not have to be made. Flat weighted measurements are frequency dependent and can only be converted to earth return current (I) when made on a single frequency basis. An overall flat weighted measurement can be used to check the accuracy of the single frequency measurements. This will be discussed in Paragraph 4.

2.3.3 This completes the measurements at a location. Move to the next location that has been selected and repeat the procedures. Continue until measurements have been completed at all desired sites.

2.4 Should measurements be desired along a route where there is no location that does not have buried cable, buried pipeline or a wire fence directly below the power line place the probe wire 50 to 100 feet away from the power line. Then repeat the procedures for measurement starting at Paragraph 2.2. This will place the probe wire beyond the influence of the buried cable, buried pipeline or fence.

3. CALCULATION OF EARTH RETURN CURRENT

3.1 Numerical values of TIF weighted amperes (I·T) and amperes (I) are calculated as shown on the form for power system current wave form analysis (Figure 1).

3.2 The first step is to convert C-MSG weighted readings in column (3) to TIF weighted dB by adding the correction factor at (2) to the reading and enter the result in the I_f , W_f dBA column (4) of the form (Figure 1). Complete this operation for each frequency and for the overall NMS reading.

3.2.1 Calculated TIF weighted amperes by the equation:

$$I \cdot T = \log^{-1}\left(\frac{(I_f \cdot W_f \text{ dBA})}{20}\right)$$

3.2.2 TIF weighted amperes may also be determined from the curve shown in Figure 3. Enter the bottom horizontal scale at the calculated $I_f \cdot W_f$ dBA value from column (4) of the analysis form. Follow the vertical line to the point it intersects the curve. Read the TIF weighted amperes (I·T) of that point on the left vertical scale. Enter value in column (5).

3.2.3 Work can be checked by calculating the power summation of columns (3) and (4) and the root sum square (RSS) of column (5). Root sum square is the square root of the sum of the squares of the individual values. Results of power summations are in decibels and results of root sum squares are in numeric units.

3.2.3.1 The equation for power summation is:

$$\text{PWR SUM} = 10 \log \left(\Sigma \log^{-1}\left(\frac{dB}{10}\right)\right)$$

3.2.3.2 The equation for root sum square is:

$$\text{RSS} = \sqrt{\Sigma I^2}$$

3.2.4 Calculated values should be nearly equal to the overall measured values in the noise measuring set mode. A large discrepancy indicates an error in either the calculations or in the individual single frequency measurements. This should be found and corrected before proceeding further.

3.3 The next step is to determine the magnitude of the unweighted earth return current. If the measurements were made with equipment not having a 20/f filter, only the recorded results of flat weighted measurements will be available. Convert the results of the flat weighted readings to 20/f values by adding the 20/f weighting factors from column (7) of the analysis form to the recorded flat readings in column (6). Enter the resulting values in column (8). Flat weighted overall readings cannot be converted to 20/f values since there is no single 20/f factor that can be applied.

3.3.1 When recorded 20/f weighted values are available, either calculated or measured, calculate the unweighted earth return current in I_f dBA. Add the correction factor (2) from the analysis form to the recorded 20/f weighted value from column (8) and subtract 40 from the result. Enter this value of the unweighted current in dBA in column (9). Complete this operation for each frequency and for the overall NMS readings.

3.3.2 The unweighted earth return current in amperes is calculated from the equation:

$$I_f = \log^{-1}\left(\frac{(I_f)\,dBA}{20}\right)$$

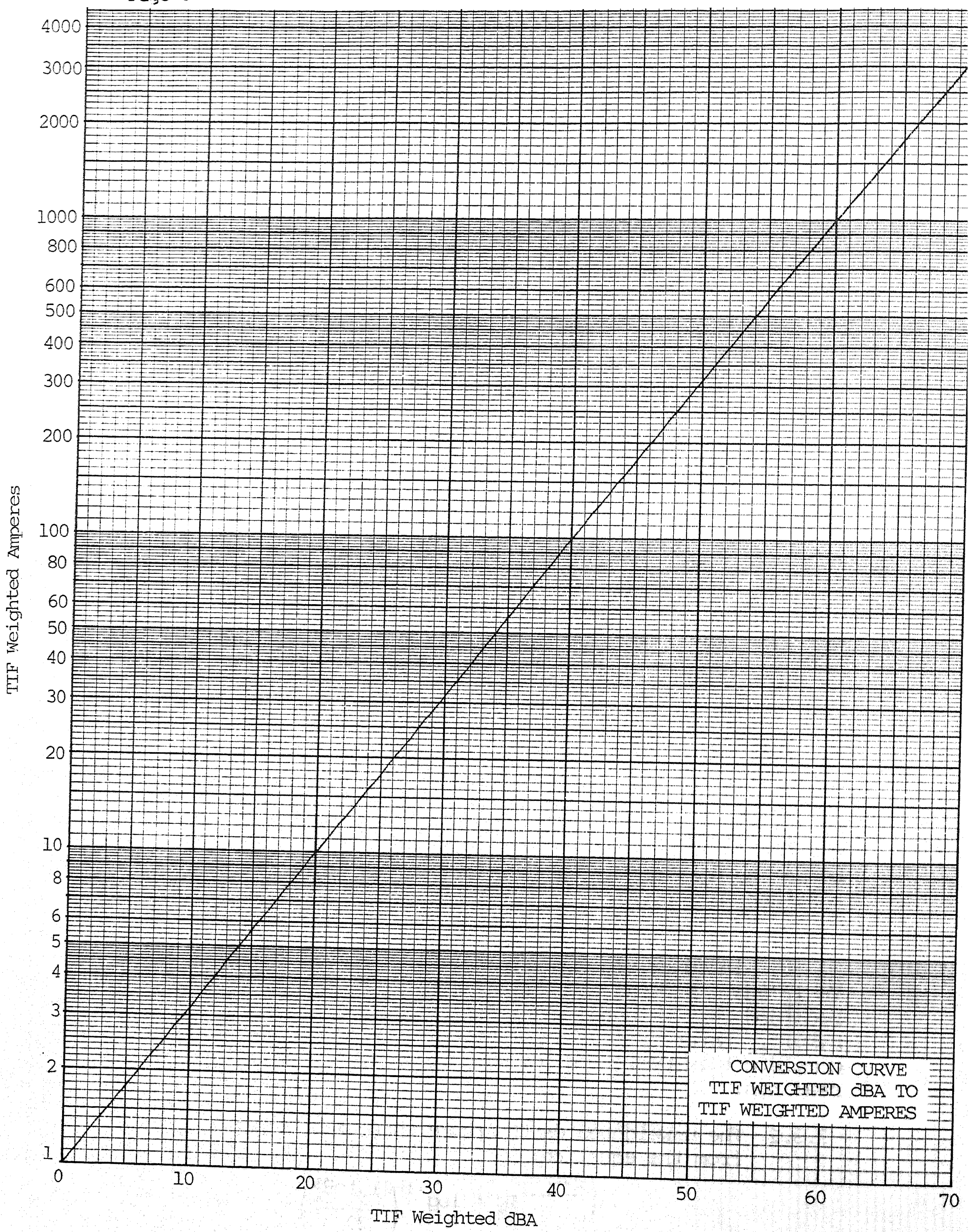
TIF Weighted Amperes
4000
3000
2000
1000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
8
6
5
4
3
2
1
0
10
20
30
40
50
60
70
TIF Weighted dBA
CONVERSION CURVE
TIF WEIGHTED dBA TO
TIF WEIGHTED AMPERES

FIGURE 3

3.3.3 The unweighted ampere value may also be determined from the curve shown in Figure 4. Enter the bottom horizontal scale at the calculated (I_f) dBA value from column (9) of the analysis form. Follow the vertical line to the point it intersects the curve. Read the value of unweighted amperes (I) of that point on the left vertical scale. Enter this value in column (10).

3.3.4 The operation can be checked by determining the power summation of columns (6), (8), and (9) and the root sum square as discussed in Paragraph 3.2.3.

3.3.5 The calculated values should be nearly equal to the overall measured values in the noise measuring set mode. A large discrepancy indicates an error in either the calculations or in the single frequency measurements. This should be found and corrected before proceeding further.

3.4 The final step is to calculate the TIF contribution of the earth return current. Subtract the 20/f reading in dBrn in column (8) from the C-MSG reading in column (3) and add 40 to the result. Enter the resulting TIF weighted dB $((T_f)\text{dB})$ in column (11).

3.4.1 Numerical TIF can be calculated by the equation:

$$\text{Numerical TIF} = \log^{-1}\left(\frac{(T_f)\,\text{dB}}{20}\right)$$

3.4.2 The numerical TIF can also be determined from the curve shown in Figure 5. Enter the bottom horizontal scale at the calculated (T_f)dB value from column (11) of the analysis form. Follow the vertical line to the point it intersects the curve. Read the TIF value of that point on the left vertical scale. Enter this value in column (12).

3.4.3 Numerical TIF may also be calculated by dividing the TIF weighted amperes from column (5) by the unweighted amperes from column (10).

3.4.4 Calculations should be completed for all individual frequencies and overall measured and calculated values. The TIF values recorded in column (12) should be nearly equal to the values shown in Table III, Power Harmonic TIF Weighting Factors, TE&CM Section 452.

3.5 An example of a completed form for power system current wave form analysis is shown in Figure 6. It is important that all of the information at the top of the form be provided. The time may indicate the data was obtained during a period of high or low load demand. This can sometimes be valuable during the analysis. Weather conditions can have a direct relationship to interference levels.

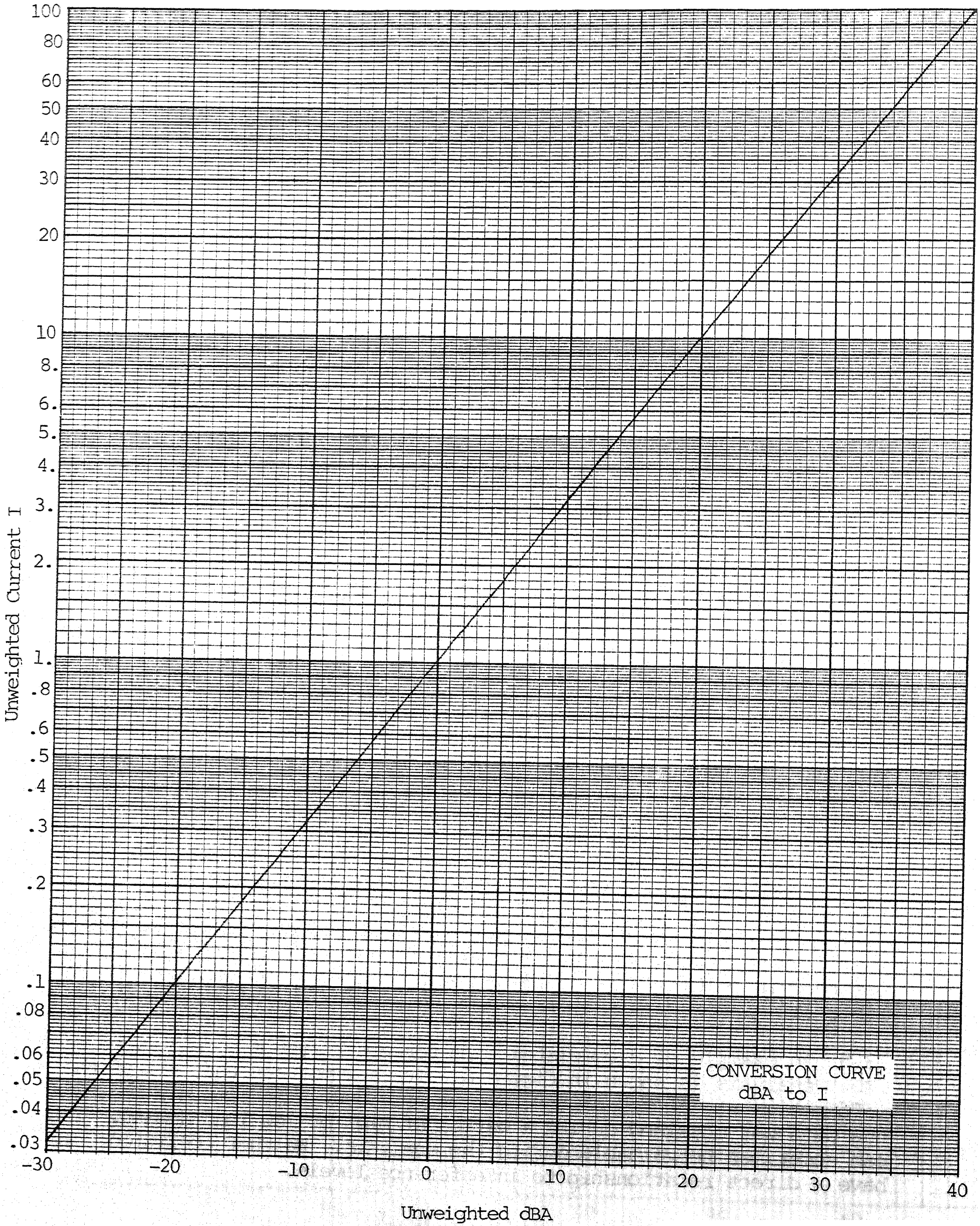
Unweighted Current I
100
80
60
50
40
30
20
10
8.
6.
5.
4.
3.
2.
1.
.8
.6
.5
.4
.3
.2
.1
.08
.06
.05
.04
.03
-30
-20
-10
0
10
20
30
40
CONVERSION CURVE
dBA to I
Unweighted dBA

FIGURE 4

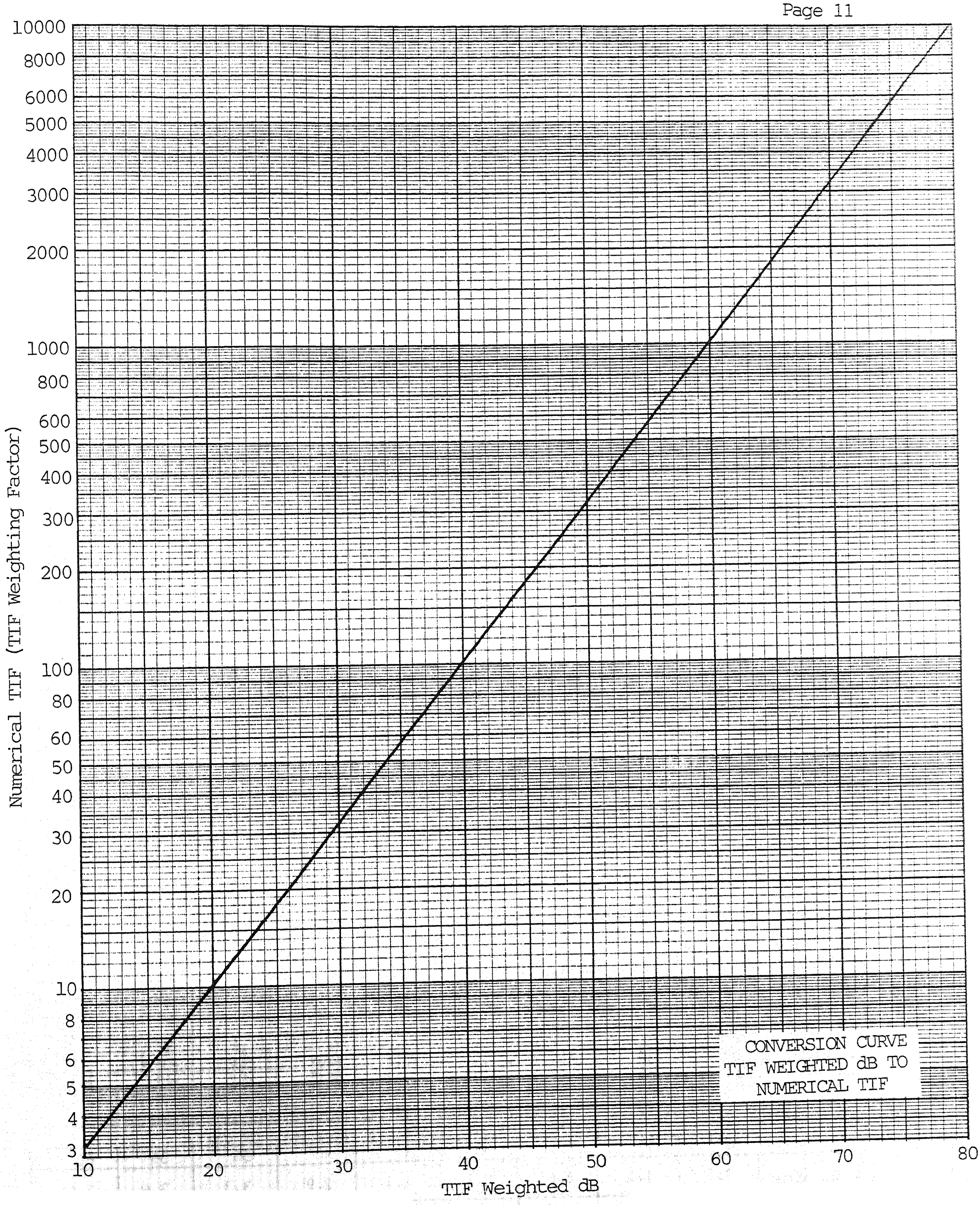
10000
8000
6000
5000
4000
3000
2000
1000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
8
6
5
4
3
Numerical TIF (TIF Weighting Factor)
10
20
30
40
50
60
70
80
TIF Weighted dB
CONVERSION CURVE
TIF WEIGHTED dB TO
NUMERICAL TIF

FIGURE 5

POWER SYSTEM CURRENT WAVE FORM ANALYSIS

Central Office ALPHA

Power Company BETA ELECTRIC Sheet No. 1

Primary Voltage 7.62 kV. 3-Phase Date 6/1/75

Test Location Adjacent to Pedestal A1-5 A1 Route Time 2:30pm

Test Condition Clear and Hot Tester Doc

☒ 100 foot probe wire ☐ Exploring coil type:

Power Line Height (Average) 31 Feet (1); Correction Factor 1.6 dB (2)

FREQ. Hz.	Harmonic	TIF Weighted (Weighing Switch in C-MSG.) Reading dB (3)	(2)+(3) $I_f \cdot W_f$ dBA (4)	$I_f \cdot W_f$ wtd. amps (5)	Unweighted (Weighing Switch in 50 KHZ-FLAT or 20/F) Flat Reading dB (6)	20/f Factor (7)	(6)+(7) or 20f Reading (8)	(8)+(2) -40 dB =(I_f)dBA (9)	I_f amps (10)	TIF Contribution (3)-(8) +40 dB =(T_f) dB (11)	T_f (12)
60	1	-			59.5	-9.5	50.0	11.6	3.8		
120	2	-			29.4	-15.6	14.0	-24.4	0.1		
180	3	24.5	26.1	20	54.1	-19.1	35.0	-3.4	0.7	29.5	30.0
240	4	-			-	-21.6	-				
300	5	40.5	42.1	127	57.0	-23.5	33.5	-4.9	0.6	47.0	224
360	6	19.5	21.1	11	33.1	-25.1	8.0	-30.4	-	51.5	376
420	7	49.5	51.1	359	59.9	-26.4	33.5	-4.9	0.6	56.0	631
480	8	22.5	24.1	16	30.4	-27.6	2.8	-35.6	-	59.7	966
540	9	58.5	60.1	1012	64.4	-28.6	35.8	-2.6	0.7	62.7	1365
600	10	22.5	24.1	16	26.9	-29.5					
660	11	28.5	30.1	32	31.4	-30.4			-		
720	12	27.5	29.1	29	29.9	-31.1					
780	13	37.5	39.1	90	38.9	-31.8					
840	14	22.5	24.1	16	23.4	-32.5					
900	15	35.5	37.1	72	35.4	-33.1					
960	16	-			-	-33.6					
1020	17	20.5	22.1	13	20.4	-34.2					
1140	19	41.5	43.1	143	41.4	-35.1					
1260	21	20.5	22.1	13	20.4	-36.0					
1380	23	32.5	34.1	51	33.4	-36.8					
1500	25	30.5	32.1	40	31.4	-37.5					
1620	27	25.5	27.1	23	26.4	-38.2					
1740	29	27.5	29.1	29	28.4	-38.8					
1860	31	23.5	25.1	18	24.4	-39.4					
1980	33					-40.0					
2100	35					-40.4					
2220	37					-40.9					
2340	39					-41.4					
2460	41					-41.8					
2580	43					-42.2					
2700	45					-42.6					
2820	47					-43.0					
2940	49					-43.3					
3060	51					-43.7					
3180	53					-44.0					
			(I·T)dB	I·T				(I) dBA	I	(TIF)dB	TIF
PWR SUM		59.2	60.8	1101	67.3		50.4	12.0	4.0	48.8	275
NMS		60.0	61.6	1202	67.9		50.9	12.5	4.2	49.1	285

Height Correction Factor dB		20'	25'	30'	35'	40'	45'	50'	55'	60'
	100' Probe Wire	0.5	1.1	1.6	2.1	2.5	2.9	3.3	3.6	3.9
	Exploring Coil	19.5	21.5	23.0	24.4	25.5	26.6	27.5	28.3	29.1

(Column group heading: Height of Power Line Above Probe Wire or Coil)

FIGURE 6
EXAMPLE-INITIAL MEASUREMENTS-EARTH RETURN CURRENT

3.5.1 In the example the distance between the lower conductor of the power system and the probe wire is 31 feet which is entered at (1). Looking at the table of height correction factors for a 100 foot probe wire at the bottom of the form a correction factor of 1.6 dB is found for a 30 feet height which is entered at (2). While a more precise correction factor (1.72 dB) can be found in Table VI of TE&CM Section 452 the resulting deviation is small and has no significant effect on the final values obtained. When the correction factors are obtained from Table VI it is necessary to change the sign before using them in the form for power system current wave form analysis.

3.5.2 Measurements are completed with C-MSG, FLAT and 20/f weighting and the results recorded in columns (3), (6), and (8) respectively at the listed frequencies. NMS mode overall readings are also made and recorded. It is not necessary to record readings at the higher harmonic frequencies when it is obvious they are at a low level and would have no bearing on the overall telephone circuit noise.

3.5.3 After the measurements have been completed and recorded the calculations described in Paragraphs 3.2, 3.3, and 3.4 are completed and the results entered on the form. Total data is now available for analysis.

4. ANALYSIS

4.1 The recorded results of measurements in the NMS mode in column (10) of Figure 6 shows an overall earth return current of 4.2 amperes. This indicates there is little likelihood of a fundamental frequency problem (excessive longitudinal 60 Hertz voltage in the telephone system). Generally when the overall earth return current approaches or exceeds 20 amperes there is a possibility of a fundamental frequency voltage problem. The I·T (TIF weighted amperes) value in column (5) is 1202 indicating that there is a possibility that the earth return current of one or more harmonic frequencies may be high enough to induce noise in a well balanced telephone circuit.

4.1.1 It is difficult to establish a precise I·T value which will indicate a noise problem will exist. The overall I·T provides a broad indication of the interference potential of a power line. Normally the I·T is not measured unless a noise problem exists and the telephone company has eliminated all potential problem areas in its system. There are situations as discussed in Paragraph 1.1 where these measurements might be completed before a problem is known to exist. As a general rule when the I·T exceeds 1000 a harmonic analysis of the earth return current should be made.

4.1.2 Study of the recorded I·T values for each harmonic frequency in column (5) reveals that all are acceptable except the 540 Hertz component which is 1012. This indicates there is a potential for telephone system noise at this harmonic frequency. As a general rule if the I·T at any frequency exceeds 500 there is a possibility of a noise problem in parallel telephone circuits. This does not, however, guarantee a noise problem cannot occur when the I·T is less than 500 but that there is a lower probability of one occurring. There are other variable contributing factors such as the length of exposure, separation between the telephone and power lines, etc. (See TE&CM Section 452, Paragraph 5).

4.2 The unweighted harmonic frequency earth return current values in column (10) show there may be significant current at four frequencies. They are 180, 300, 420, and 540 Hertz with currents of 0.7, 0.6, 0.6, and 0.7 amperes, respectively. There is little chance of 180 or 300 Hertz contribution to the noise problem due to the low I·T. There is a possibility that the 420 Hertz component might be contributing to the telephone system noise if there is a long exposure. The 540 Hertz component appears to be the principal contributor in this case. When long exposures are involved a 540 Hertz earth return current as low as 0.1 ampere should not be regarded as being insignificant. A substantial longitudinal voltage may be induced in a parallel telephone system which should not automatically be considered a power system problem since the I·T would only 132. (See TE&CM Section 452, Paragraph 5).

4.3 Comparison of the numerical TIF values from column (12) to those from Table III of TE&CM Section 452 shows a good correlation:

Frequency	Column (12)	Table III
180 Hertz	30	30
300 Hertz	224	225
360 Hertz	376	400
420 Hertz	631	650
480 Hertz	966	950
540 Hertz	1365	1320

4.4 The differences between numerical TIF and Table III values are to be expected as are those between the results of overall NMS measurements and power summations. They occur because it is not possible to complete all of the measurements at precisely the same instant in time. During the time period required for completion of the series of measurements there will be power system load variations that will produce these minor variations. When there is a large difference there is a likelihood an error has occurred and a second measurement should be made.

4.5 The 540 Hertz component will be the predominant harmonic in the majority of noise investigations. Power line resonance is often a factor which can be further aggravated by capacitor bank installations. In the example (Figure 6) a capacitor bank located on the field side of the measurement location is assumed. Study of the recorded data would justify a suspicion that there is a power line resonance that is being aggravated by the capacitor.

4.6 Additional measurements of the harmonic frequency earth return currents are completed at other locations to confirm the tentative diagnosis. It will be assumed that the recorded results of a measurements at a location on the field side of the capacitor bank shows an IT of 442 at 540 Hertz with an earth return current of 0.3 ampere. While this is still marginally high it does appear to confirm that the capacitor bank is a major contributor to the noise problem.

4.7 Enough information has now been accumulated to determine that a condition in the power line operation is apparently the principal contributor to the telephone system noise. Even more important the information is in units (I·T and I) which are familiar to a power company engineer and assist him in making decisions regarding possible actions for relieving the problem. Even though a telephone engineer or technician may make some reasonable assumptions relative to the noise contribution from various power system components final determinations should be left to the power company. It is at this point in a noise investigation that the power company should be contacted.

4.7.1 All of the power system current wave form data is presented to the power company. Additional information is also provided showing work which has been performed by the telephone company to determine that telephone shields are continuous and adequately grounded and that telephone circuits have excellent balance. The power company representatives may agree after looking at the data with the tentative diagnosis that there appears to be a capacitor related problem or they may indicate a desire to perform tests themselves. A possible course of action is to negotiate the temporary removal of the ground connection to the capacitor bank during which period additional measurements are made. For the purposes of the example it will be assumed the ground connection has been removed temporarily.

4.7.2 Probe wire measurements as described in Paragraph 3.5 are made at the same location as those shown in Figure 6. Results of these measurements are recorded in the form for power system current wave form analysis as shown in Figure 7. The I·T at 540 Hertz has been reduced from 1012 to 23. The calculated earth return current is about 0.017 ampere. The IT at 420 Hertz has been reduced from 359 to 320 and the earth return from 0.6 to 0.5 ampere. This clearly indicates the capacitor bank is a significant factor in the noise problem.

POWER SYSTEM CURRENT WAVE FORM ANALYSIS

Central Office: ALPHA

Power Company: BETA ELECTRIC   Sheet No. 2

Primary Voltage: 7.62 kV 3-Phase   Date 6/2/75

Test Location: Adjacent to Pedestal A1-5 A1 Route   Time 10:30 am

Test Condition: Clear and Hot   Tester Doc

☒ 100 foot probe wire ______   ☐ Exploring coil type: ______

Power Line Height (Average) 31 Feet (1); Correction Factor 1.6 dB (2)

FREQ. Hz.	Harmonic	TIF Weighted (Weighing Switch in C-MSG.) Reading dB (3)	(2)+(3) $I_f \cdot W_f$ dBA (4)	$I_f \cdot W_f$ wtd. amps (5)	Unweighted (Weighing Switch in 50 KHZ-FLAT or 20/F) Flat Reading dB (6)	20/f Factor (7)	(6)+(7) or 20f Reading (8)	(8)+(2) −40 dB =(I_f)dBA (9)	I_f amps (10)	TIF Contribution (3)−(8) +40 dB =(T_f) dB (11)	T_f (12)
60	1	–			58.5	−9.5	49.0	10.6	3.4		
120	2	–			28.5	−15.6	12.9	-25.5	0.1		
180	3	20.5	22.1	13	49.0	−19.1	29.9	-8.5	0.4	30.6	34
240	4	–			17.5	−21.6	-4.1	–			
300	5	41.5	43.1	143	59.0	−23.5	35.5	-2.9	0.7	46.0	200
360	6	18.5	20.1	10	31.5	−25.1	6.4				
420	7	48.5	50.1	320	59.5	−26.4	33.1	-5.3	0.5	55.4	589
480	8	20.5	22.1	13	28.5	−27.6	1.0				
540	9	25.5	27.1	23	31.5	−28.6	3.0				
600	10	15.0	16.6	7	19.5	−29.5					
660	11	36.5	38.1	80	39.0	−30.4					
720	12	19.2	20.8	11	17.5	−31.1					
780	13	38.8	40.4	105	38.5	−31.8					
840	14	–			–	−32.5					
900	15	34.0	35.6	60	34.5	−33.1					
960	16	–			–	−33.6					
1020	17	41.5	43.1	143	41.5	−34.2					
1140	19	40.5	42.1	127	40.5	−35.1					
1260	21	37.5	39.1	90	38.0	−36.0					
1380	23	36.5	38.1	80	37.0	−36.8					
1500	25	28.8	30.4	33	29.5	−37.5					
1620	27	20.5	22.1	13	21.5	−38.2					
1740	29	30.3	31.9	39	31.3	−38.8					
1860	31	23.5	25.1	18	24.7	−39.4					
1980	33					−40.0					
2100	35					−40.4					
2220	37					−40.9					
2340	39					−41.4					
2460	41					−41.8					
2580	43					−42.2					
2700	45					−42.6					
2820	47					−43.0					
2940	49					−43.3					
3060	51					−43.7					
3180	53					−44.0					
			(I·T)dB	I·T				(I) dBA	I	(TIF)dB	TIF
PWR SUM		51.4	53.0	446	64.0		48.3	10.9	3.5	42.1	127
NMS		50.9	52.5	422	62.9		48.6	10.2	3.2	42.3	130

		Height of Power Line Above Probe Wire or Coil								
		20'	25'	30'	35'	40'	45'	50'	55'	60'
Height Correction Factor dB	100' Probe Wire	0.5	1.1	1.6	2.1	2.5	2.9	3.3	3.6	3.9
	Exploring Coil	19.5	21.5	23.0	24.4	25.5	26.6	27.5	28.3	29.1

FIGURE 7
EXAMPLE-SECOND MEASUREMENT-EARTH RETURN CURRENT

4.7.3 The next action is to negotiate with the power company to determine if the capacitor bank can be relocated to a point nearer to or at the power substation to reduce the length of exposure. Such action would provide a final solution for the problem.

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